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13. ABSTRACT (Maximum 200 Words)

Hardware requirements for the Polish military telemedicine system are enormous. Modern ruggedized versions of commercial equipment need to be installed. The system should be linked to the transmission network with large archiving capability. Translation into Polish should be relatively straightforward but all the changes and modifications may be difficult and time-consuming if the source code is in the United States. Licensing the source code to one of the Polish companies (Consortia) is a potential solution. The main limitations of military telemedicine are the existing network infrastructure and quality of equipment. Planned network solutions should meet suitable link parameters(bandwidth, delay, QoS etc).

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1. INTRODUCTION

Medical consultation for Polish troops in Iraq is not readily available. A telemedicine and teleconference system allowing consultation in the most complicated cases is needed. Implementation of a telehealth system based on advanced US technology needs to be integrated with the existing infrastructure of the Polish Health Service in Iraq. This objective requires creating a telehealth infrastructure and secure access to the internet for mobile videoconference and teleconsultation. The completion of this task is made possible by the infusion of modern telemedicine equipment for the use by Polish Ground Forces in Iraq. Customizing the software and training of medical personnel may be essential to achieve success.

Healthcare may present some unique problems in the implementation of automated information systems. Systems engineers have addressed similar problems introducing technology into other businesses for some time. Sage [1] mentions the following list of potential pitfalls in telemedicine system implementation:

- There may be an over-reliance upon a specific analytic tool or technology that is advocated by a particular group.
- Perceived needs and problem resolution activities may be considered only at the level of symptoms but not at the level of institutions or values.
- There may be a failure to develop and apply an appropriate methodology for issue resolution.
- There may be a failure to involve the client in problem resolution or systems design alternatives where necessary.
- There may be a failure to consider the effects of cognitive biases that result from poor information-processing heuristics.
- There may be a failure to identify a sufficiently robust set of options or alternative courses of action.
- There may be a failure to identify risks associated with the costs and benefits or effectiveness of the system.
- Risks may be organizational and environmental as well as technological.
- There may be a failure to properly relate the designed system to the cognitive style and behavioral constraints that affect the user, i.e. poor design of the human interface.

- Improper attention may be paid to the needs of reality, availability, and maintainability. This may arise from the lack of understanding of a system life cycle.
- There may be a failure to integrate the system under development with the existing systems in the environment.

Teleconsultation requires a high quality videoconferencing capability. There are many technical problems regarding establishing a network connection in teleconsultation. The most important issues are connected with an access of all teleconference participants to the network connection and determination of network parameters such as bandwidth, delay, etc. These parameters change in time (e.g. in the day cycle it is necessary to verify them). Unlimited and easy access for authorized users (laptops and PDAs), even from remote areas, is one of the directions that military telemedicine is heading towards [2].

The present research investigation presents some possibilities of infusing and integrating U.S. telemedicine technology for use by Polish Armed Forces in Iraq.

1.1 HYPOTHESIS:

The hypothesis is that US advanced telemedicine technologies can be integrated to provide a seamless communication within the Polish Telemedicine System for use by Polish Armed Forces serving in Iraq and in other operational areas.

1.2 TECHNICAL OBJECTIVE:

The technical objective is to determine the feasibility of infusing and integrating US telemedicine technology for use by Polish Armed Forces in Iraq.

1.3 MILITARY SIGNIFICANCE:

The technological upgrade of military telemedicine is very important for Polish Armed Forces engaged in Iraq and other operational theatres, as rapid and effective medical treatment is essential in hostile environments. Combat trauma cases are difficult to treat and they may overwhelm Polish medics, who typically are young surgeons and doctors acting under enormous pressure.

Research concerning advanced technology infusion and integration is crucial for combat readiness of the fighting force. The proposed US/Poland Cooperative Telemedicine Program seeks to apply recent U.S. military technology advances for the rapid collection of

medical information from injured soldiers. If implemented, it will enhance the treatment of injured combatants and will promote the creation of a seamless, wireless telemedicine system for use by Polish Armed Forces serving in Iraq

Military hospitals with enhanced specialist service may act as the interface between the local people and military troops. Good relations with the Iraqis may save many human lives since they often warn soldiers about possible danger. Additionally, a reliable telemedicine system may serve as the alternative communication link between military troops. It may further enhance the security of soldiers in convoys and in operational areas.

1.4 METHODS:

This project consisted of research and information seeking initiatives. Consortia scientists assessed the telemedicine requirements of the Polish Armed Forces in Iraq and the status of the infrastructure in Poland in view of planned telemedicine links. Over a period of three months, all available sources were used to collect the most recent and accurate data. The information was reviewed by doctors and IT specialists from the Military Institute of Health Service and from the Polish Armed Forces in Iraq. All classified information was not included in the report. Official published bulletins of the General Staff and Directorate of Military Medical Service and General Command of Telecommunication (J6) were also reviewed.

2. KEY RESEARCH ACCOMPLISHMENTS:

The organizational structure of Polish Military Medical Service in Multinational Division (MND) in Iraq

The main objective of the Polish Military Medical Service in Iraq is providing medical service 24 hours per day. Every brigade is responsible for the medical care of its staff. The medical service is divided into different levels of Medical Evacuation (Medevac). Polish Military Medical Service covers Medevac levels 1 and 2 (2+).

In the MND Staff, a special department has been organized – TOC (Tactical and Operation Center). It includes the Medical Officers from the PET (Patient Evacuation Team), who coordinate the medical support in case of emergency, especially when the helicopter Medevac is needed. All more serious treatment requiring specialized help beyond 2+ hospital capabilities are evacuated to the level 3-28th Combat Support Hospital in Baghdad (3).

The feasibility of infusing and integrating U.S. telemedicine technology for use by Polish Armed Forces in Iraq will be described according to Medevac levels.

LEVEL 1

At this level the Polish Medical Groups are operational (equivalent of Troops Medical Clinics - TMC). Their tasks include:

In the operational site:

- Casualty evacuation
- Basic Life Support
- Advanced Life Support available within 15 minutes.
- Level One medical treatment up to 3 days.
- Convoy support

Off-site:

- medical advice
- primary and secondary prevention against disease and stress
- basic medical treatment.

At this level humanitarian aid is provided to the local people. So called "white days" are organized for the benefit of the civilians. It is an important factor for improving relations between the allied troops and the Iraqis.

Implementation and integration of telemedicine technologies - Level One.

Considering the assignments listed above, medical personnel from the Polish TMCs should have a telemedicine link with level 2. However it is not necessary for them to have this connection capability with Poland. Radio remains the main communication tool within Medevac level 1. Due to space restrictions and the necessity to be easily transportable, it seems that the TMC should be equipped with the following telemedicine technologies.

- portable, packed in rigid-case containers, light and "ruggedized" telemedicine stations such as Voyager (Aethra) or similar Vitel-Net equipment
- capability to establish connection to the radio TRC 9200, 9500 and Harris stations with the "ruggedized" laptop while in a medical vehicle
- satellite connection capability in the First Aid and Dressing Station (portable antenna)

- BMIST – Battlefield Medical Information System Tactical - a system developed by TATRC based on hand held devices (PDAs) is an essential tool for military trauma patients.

BMIST is a point-of-care hand-held assistant that enables military healthcare providers to record, store, retrieve and transmit the essential elements of clinical encounters in an operational setting. Reference materials, diagnostic and treatment decision aids, and logistic support software can also be included, facilitating patient care, skill sustainment training, and mission planning. Initially designed for special forces medics and other first responders, BMIST can be used by providers at all echelons along the healthcare continuum. As medical practice evolves, BMIST has the flexibility to incorporate new procedures protocols, languages, medical databases and mission requirements.

LEVEL 2

Organizational structures and tasks

The Polish Medical Support Group (Polish Field Hospital) is the Department of Defense Health Care Unit at the level (2+) of medical evacuation in the Multinational Division Center South -MND CS) in Iraq. It is a part of the 1st Brigade Combat Team and the hospital commander is the Chief of Health Service of the Brigade. There are two Polish Battalions and one Bulgarian Battalion (4).

The Medical Support Group provides medical services to all casualties, ill soldiers and civilians of ground forces including the Iraqi soldiers. It also provides humanitarian aid to the Iraqi population. It provides health care for all military personnel including Americans (soldiers and civilians). Recently due to the fact that the location of the MND has changed this hospital is located within the American Armed Forces controlled zone. The service is based on 24 hour shifts. The organizational structure is comprised of:

- Command
- Accident and Emergency (Fig. 1)

Fig. 1. Accident and Emergency Room, Polish Field Hospital, Lima Military Base, Karbala

- Surgery and Anaesthesiology : Operation Room, Pre-Op room, intensive therapy room – 4 beds
- The hospital ward - 30 beds including 6 isolators
- X-ray room
- Medevac Team
- Laboratory
- Pharmacy
- Dentist room
- Psychology room

The main tasks include:

1. stabilizing life functions
2. out-patient and in-patient treatment (up to 7 days)
3. preventive psychology
4. disease prevention
5. medical supplies
6. medical evacuation (MEDEVAC) co-ordination
7. MEDEVAC training

Morbidity and trauma ratios are presented at Fig. 2. As one might expect, combat traumas are the main problem within the Polish Field Hospital. A significant percentage of them are very complicated and need immediate specialist consultation [5]. Therefore the first line need for a telemedicine system is to establish a seamless teleconsultation link with the

Military Institute of Health Services in order to start online consultations on most complicated cases. Teleradiology and other telemedicine applications should follow.

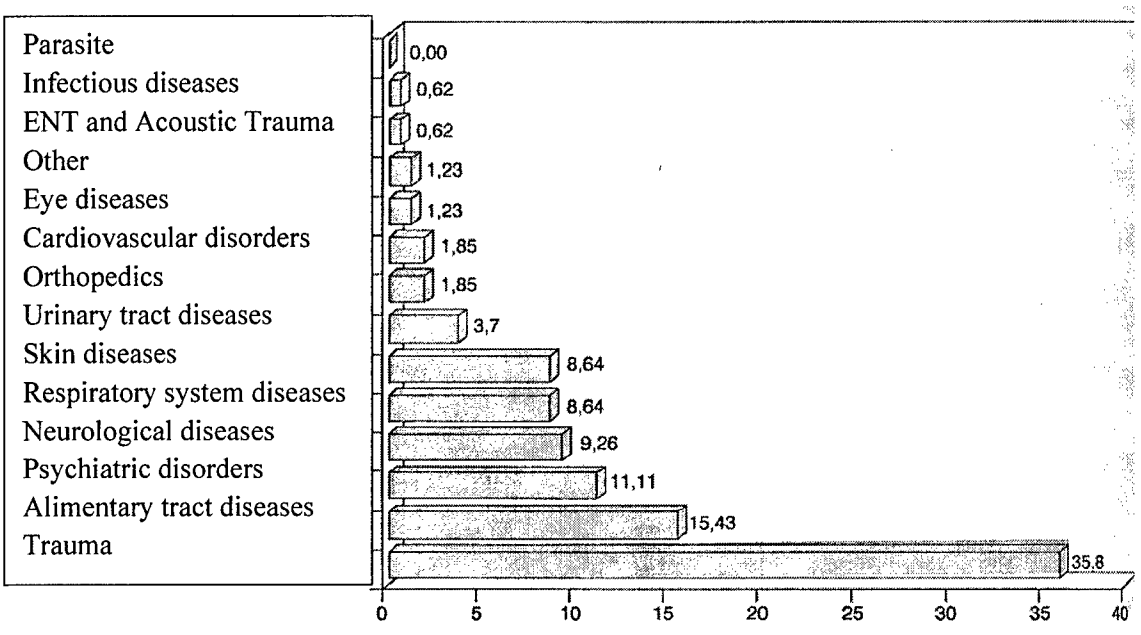


Fig. 2. Morbidity and trauma ratios (in %) among admitted active duty personnel, Karbala [5].

During "white days" initiatives in September and October 2004 five hundred fourteen Iraqi civilians were treated. This direct support and help seems to be most appreciated by the Iraqi local population and results in their respect and trust of the good intentions of the allied forces in Iraq (Fig 3).

Fig 3. Medical consultation for Iraqui civilian, Polish Field Hospital, Lima Military Base, Karbala, Iraq.

Co-operation with the Iraqi Hospital in Karbala started on November 4th 2004.

Support for the civilian hospital will include:

- Laboratory tests
- X-ray scans reporting
- Surgical and anaesthesiologist help

Future plans regarding the Polish Field Hospitals

The first Polish Medical Support Group (Field Hospital in Karbala), consisting of 10 containers should remain operational at least until the end of April 2005. Then a new hospital is planned to arrive in Diwanijah – the location of the MND headquarters..

The construction of the 2nd Field Hospital is being accomplished at the 5th Regional Technical Workshop in Bydgoszcz (5. Rejonowy Warsztat Techniczny). Additionally 20 – foot containers (Fig. 4) and medical equipment has been purchased. The laboratory is also ready. The 2nd Field Hospital (Level 2+) will be ready for deployment by the end of February 2005.

According to the Polish Directorate of Military Medical Service, by the end of 2006 there will be 3 Field Hospitals: Bydgoszcz, Warsaw and Wroclaw. These field hospitals will employ 70 medics and doctors each.

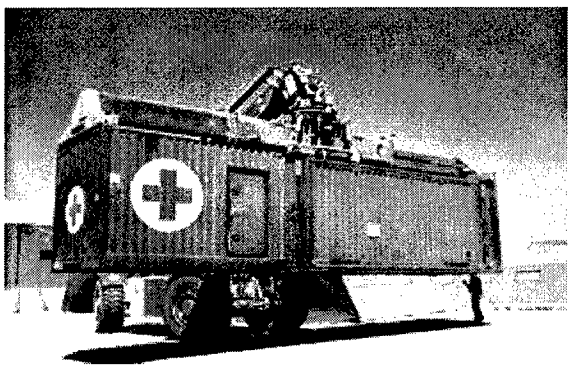


Fig 4. One of the containers that are being used by the Polish Field Hospital, Karbala.

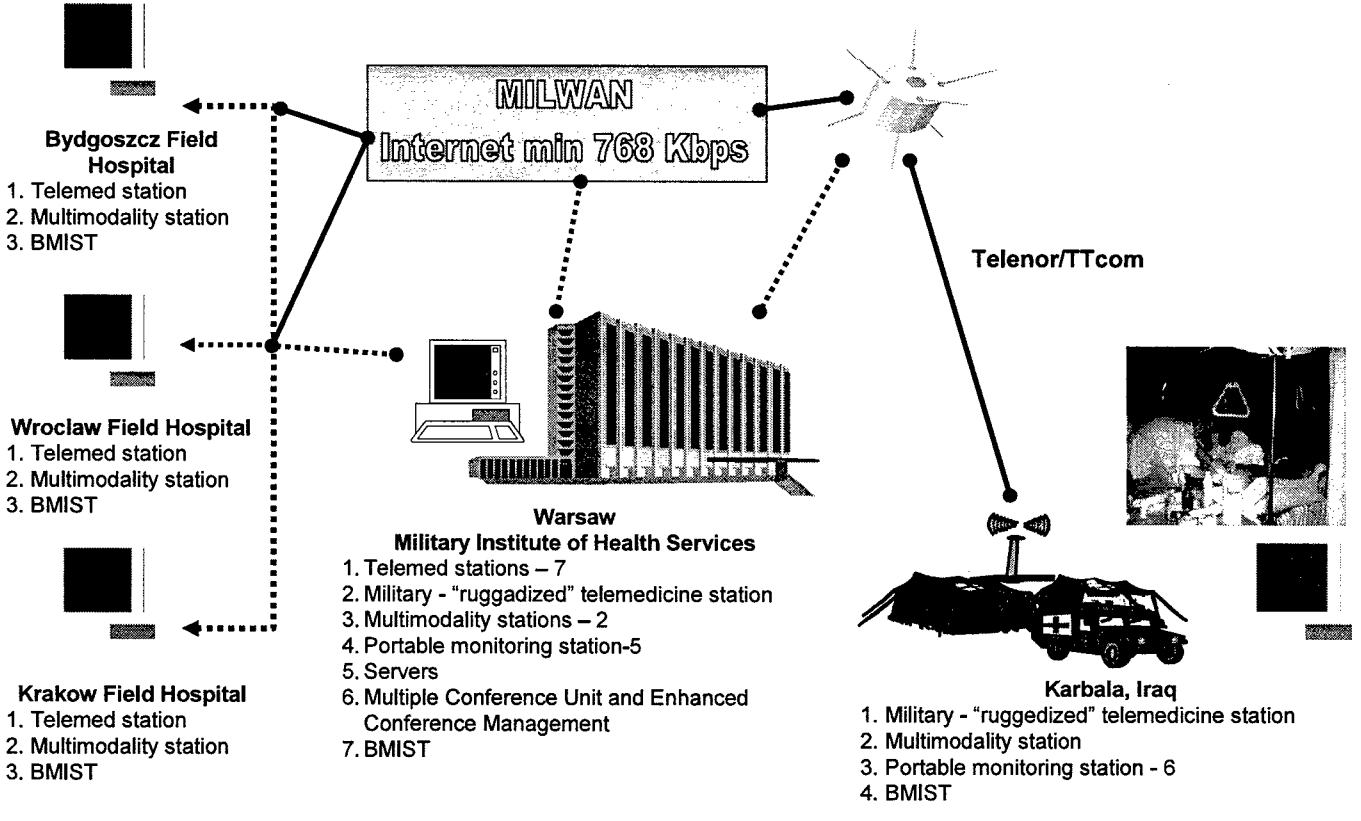
Implementation and integration of telemedicine technologies Level Two

Considering the assignments listed above, the Polish Medical Support Group (Polish Field Hospital) should have a telemedicine connection with Medevac Level 1 and 3 and a permanent active telemedicine link to Poland. The bandwidth should be guaranteed (Fig. 5).

The telemedicine links should be based on the IP network with the 4x ISDN BRI as the

reserve connections. The satellite connections from Iraq to Poland are provided by the Polish company TTcomm SA. (former Telenor). Due to security reasons, the MILWAN (Military Wide Area Network) or Military Internet was chosen as the main transmission media. Restrictions about the size and weight of the equipment are not as stringent as Level 1. The following telemedicine equipment is necessary to establish the telemedicine system at the Level 2:

Figure 5. Telemedicine system for the Polish Armed Forces including those in Iraq. TMC (Troop Medical Clinics - Grupa Medyczna). MILWAN – Military Wide Area Network. Solid lines represent the existing links, dotted – work in progress.



- Full profile telemedicine station (military version) able to support:

  HL7 and DICOM

  telemonitoring

  X-ray film scanner

  Additional camera in the operation theater

- portable, packed in rigid-case containers, light and "ruggedized" telemedicine stations such as Voyager (Aethra) or similar Vitel-Net equipment
- capability to establish connection to the radio TRC 9200, 9500 and Harris stations with the "ruggedized" laptop while in medical vehicle
- satellite connection capability (full –size antenna)
- BMIST – Battlefield Medical Information System Tactical

CONSULTING SIDE - POLAND

The existing and planned telemedicine links are presented in Fig. 5. They should help to establish the following telemedicine points in the following departments:

Warsaw (Military Institute of Health Service and Warsaw Field Hospital).

1. Surgery and Vascular Surgery
2. Orthopedics and Traumatology
3. Internal Disease and Casualty Care (movable point)
4. Conference room (movable teleconference/teleconsultation/training point)

Bydgoszcz (Field Hospital)

Wroclaw (Field Hospital)

Krakow (Field Hospital)

Technologies and equipment needed for the consulting side of the Polish Military Telemedicine System is presented in Table 1 and Fig. 5.

Scenarios of teleconference

In telemedicine we can identify three potential scenarios of teleconsultation:

- High quality scenario (based on MPEG codecs)
- Conference based on H.323 codecs
- Voice (phone) teleconsultation

Table 1. The specification of equipment required for the integration of telemedicine systems.

No.	Location	Equipment		
		Type		Number
1.	Warsaw	1.	Medical Videoteleconference Station	7
		2.	Military version of the Videoteleconference Station	2
		3.	Multimodality Station	5
		4.	Turtle – military version	2
		5.	Multipoint videoconference equipment: 1. Multipoint Conference Unit 2. Bridge 3. Gateway TCP/IP <-> ISDN (4. Gatekeeper 5. Enhanced Conference Management	1
		6.	Additional servers for a software of the multipoint videoconference equipment, teleconference and videoconsultation	2
		7.	Videoconference software	For each station
2.	Bydgoszcz	1.	Medical Videoteleconference Station	1
		2.	Multimodality Station	1
3.	Wroclaw	1.	Medical Videoteleconference Station	1

		2.	Multimodality Station	1
4.	Krakow	1.	Medical Videoteleconference Station	1
		2.	Multimodality Station	1
5.	Polish Health Service in Iraq and Karbala	1.	Military version of the Videoteleconference Station	1
		2.	Mobile Telemedicine Station	12
		3.	Telemonitoring station	6

Every scenario requires special technical conditions connected with suitable network parameters (for example bandwidth, delay etc.). These scenarios including almost all potential applications of medical teleconsultation depend on requirements and infrastructure (hardware, software and network). According to the model of teleconsultation, there are referential centers (for example experts in renowned clinics) and local points of care (e.g. field hospitals). These scenarios are used for almost only point to point connection (according to the assumption model). The costs of hardware and software in these solutions are different, from the most expensive (fast network, encoder MPEG1/2) to the cheapest voice teleconsultation. The most important technical aspect is the configuration workstation for telemedicine.

In software solutions, the standard for A/V coding in IP and ISDN network is H.323. Features of this standard, such as low bandwidth and popular application (for example NetMeeting in Microsoft Windows operating systems) make H.323 widely popular in teleconferencing. The MPEG 1 and MPEG2 compression standards are also very popular. Because of this standards requiring high bandwidth (MPEG1 about 1 Mbps, MPEG2 about 6 – 8 Mbps) are useless in software scenarios (Fig. 6).

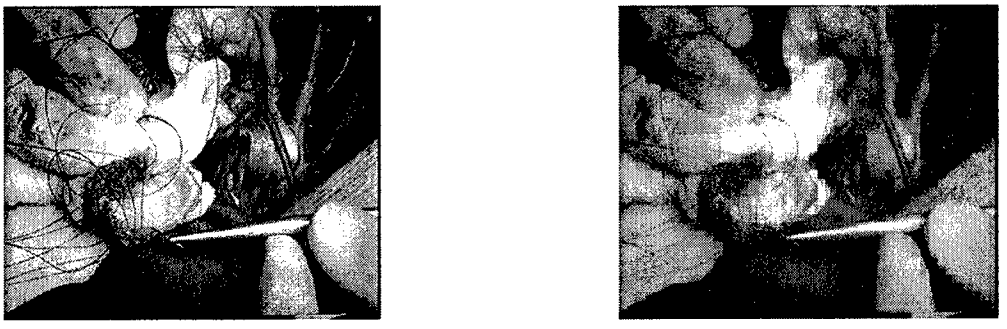


Fig 6. Two standards of teleconference - MPEG and H.323 (left and right respectively)

The hardware solutions are very often based on MPEG standards. Currently MPEG1 and MPEG2 formats are used but in the future MPEG4 will be used. MPEG$ is not widely available in Poland. In "open" solutions encoders are often PCI cards in computers. These encoders are rarely integrated. Usually integrated MPEG systems are professional solutions, taking advantage of television. Low cost, widely used solutions have encoders PCI cards with dedicated software. There are exist devices where encoding and decoding cards are integrated and products where cards are separate. The main problem is the choice of encoding standard. In the past the MPEG1 standard was often used. Its quality of A/V stream was similar to analog TV transmission and the bandwidth compressed stream was about 1380 kbps. The MPEG1 is suitable for live medical teleconsultation on the condition that the network has appropriate bandwidth. A more complete standard of A/V coding is MPEG2. The quality of A/V stream is comparable to quality digital satellite television and the bandwidth is about 6500 kbps. Requirements for the network are high and the cost of this solution can be too high for medical practice. The newest standard of MPEG4 is a combination of MPEG1/2 standards and in the future can replace old solutions.

Software, archiving and technical support.

Due to the size and volume medical data require large disk space (up to several terabytes). It is important to use the most effective methods for data storage, searching, retrieving and transmitting. Those tasks are performed by advanced databases and specific medical data transmission protocols [6].

The hardware requirements for military telemedicine systems are enormous. They begin with modern "ruggedized" versions of commercial equipment. They also should be linked to broadband access to the transmission network and large archiving capability.

Due to the fact that software will be created on demand and tailored to the Polish Telemedicine end-user needs, there may be some problems in the future with technical and expert support (possible amendments, format changes, etc.). Translation into Polish should be relatively straightforward but all the changes and modifications may be difficult and time-consuming if the source code was in the United States. Licensing of the source code to one of the Polish companies (Consortia) could solve that problem.

Similarly technical support should conducted by Polish contractors. Immediate and professional support is crucial for the integrity of the system and usually demanded by the end-user.

3. DISCUSSION

The results of the current research show the structure of the telemedicine service scenario should include:

1. Videoteleconferencing in order to establish direct contact between the patient or medic and a consultant explaining the physical status of the patient.

2. A system of real time transmission of static images captured from analog/digital imaging devices or dynamic (movies) presented on TV screens.

3. On-line or off-line transmission of DICOM format files with immediate visualization or DICOM streaming and visualization.

4. Easy access to patient and study databases including imaging modalities with DICOM viewing. Additionally the storage of the teleconsultation or telesurgery activities should be available.

5. It seems that wireless access to medical data from an operational site will be useful (BMIST).

In order to build the Telemedicine System for the Polish Troops in Iraq adequate equipment and technological support is needed. Modern telemedicine environments require appropriate architecture and software solutions.

From among different operating systems that are possible for use in teleconsultation workstations, the most suitable is MS Windows 2000. It seems probable that in the future another operating system - Linux may be useful for multimedia teleconference. The most important aspect for creating a superior teleconsultation system is choosing the best technology for compression of the audio/video stream.

The newest MPEG standard - MPEG4 – may be useful in teleconsultation based on only software solutions. Many features from the MPEG1/2 standard make this solution very useful and popular. The MPEG4 format provides a quality of video stream comparable to MPEG2 and provides bandwidth that is lower than MPEG1. It seems that this format will be popular in the future when all the design and implementation modifications are made.

Apart from software solutions, there are some hardware systems for teleconsultation. It is possible to distinguish between available solutions. The first group has equipment which connects through ISDN or IP, ATM networks. The second group has solutions based on MPEG standards where bandwidth must be high and only IP and ATM networks can be use in teleconsultation.

The integration and interoperability of telemedicine capabilities will enhance the capability to gather greater information concerning the patient and will enable a healthcare provider to consult with a distant medical expert while attending to the soldier. Immediate access to essential clinical and patient information and medical expertise at the point of care will improve military and civilian healthcare by improving medical decision making and reducing errors.

Size and weight of the hardware, interoperability of wireless systems, and bandwidth limitations continue to be obstacles to the systems developer. These obstacles, coupled with the need for a hands free medical information and data entry system must be overcome to provide a useful telemedicine instrument for the health care provider from the point of first encounter through the care and evaluation chain to completion of care. Due to the fact that military forces must operate on a hostile physical and electronic battlefield, additional communication and security technological barriers must be overcome.

Another important obstacle is the integration and accessibility of relevant patient and medical information. In addition to raw data and images, medical records, guidelines, and decision support tools must be made available to the health care provider. Information from these systems must be able to be retrieved across the entire continuum of health care providers via communication network such as BMIST

It is worth mentioning that now in Iraq each transport or convoy is exposed to substantial risk of terrorist attack. This danger also exists for medical vehicles. Thanks to telemedicine solutions the number of medical convoys for transportation should be decreasing. This technological support will ensure that medics will work in the most comfortable environment possible and that standards of medical care will improve significantly.

4. CONCLUSION:

The suggested final version of the Military Medicine System is planned to be developed according to the timeline provided by the following Plan of Action and Milestones.

Task1. Create telemedicine link between the Military Institute of Health Service (MIHS) and Polish field hospital in Karbala

SUBTASK	ORGANIZATION	DATE
a. Identify hardware and software	MIHS/Consortia	March 05
b. Purchase equipment	Consortia	April 05
c. Install equipment	VitelNet/Consortia	May 05
d.Test/evaluate/configure equipment	VitelNet/Consortia	June 05
e. Prepare for Karbala test	VitelNet/Consortia	July 05
f. Install equipment	VitelNet/Consortia	August 05
g.Test/evaluate/configure equipment	VitelNet/Consortia	August 05
h. Progress Report	VitelNet/Consortia	September 05

TASK 2. Create telemedicine link at Bydgoszcz, Wroclaw and Krakow hospital

SUBTASK	ORGANIZATION	DATE
a. Identify hardware and software	MIHS/Consortia	October 05
b. Purchase equipment	Consortia	November 05
c. Install equipment	VitelNet/Consortia	December 05
d.Test/evaluate/configure equipment	VitelNet/Consortia	January 06
e. Progress Report	VitelNet/Consortia	February 06

The main limitations of military telemedicine are the existing network infrastructure and quality of equipment. The planned network solutions should meet suitable parameters of link (bandwidth, delay, QoS etc). Multimedia transmission requires continuous transfer of data. Without proper equipment and without providing transmission parameters on a network level, it might be difficult to organize a quality Polish Military Telemedicine System.

However, provided the US telemedicine equipment meets scalability and interoperability requirements, the infusion and integrating of US telemedicine technology for use by Polish Armed Forces in Iraq is feasible and should result in an improved standard of medical care for both Polish and American soldiers.

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